Space Weather Technical Forecast

Issued on Sunday, 19 May 2024 at 00:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-class flares likely with a slight chance of isolated X-class flares throughout. A chance of G1-G2 (Minor/Moderate) Storm conditions day 2 and 3 (20 and 21 May) with potential glancing CME impacts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was at Low levels, with the highest a C7.2 flare observed at 18/0538 UTC from AR3679. There are currently nine sunspots on the visible disc, with AR3670 fading from view. There has been little change overall since the last summary, with the visible sunspots only slowly evolving. The largest region on the disc is AR3685 in the southeast. The region is composed of a number of large, mature spots with several much smaller spots of mixed polarity present. AR3679 near centre-disc is the next largest region and has been the source of some C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 in the southwest indicates modest magnetic complexity with numerous small spots at this time. The other sunspot regions are generally smaller, simpler and more stable.

No Earth directed CMEs observed in available imagery, although we await coronagraph imagery for a large filament liftoff from the southern hemisphere that began around 18/2200UTC.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE were indicative of waning CME effects, with initially slightly elevated winds around 450km/s steadily decreasing through the period to background levels around 390km/s. Density of the solar wind was average to below average throughout. The Interplanetary Magnetic Field (IMF), Bt, was initially moderate around 12nT, but steadily reduced to weak levels around 5nT by 18/1200 UTC where it remained. The north-south component Bz was predominantly weakly negative to start the period but increased from 18/1200 UTC to become more generally natural. Phi angle was negative (towards the Sun) to start, becoming positive (away from the Sun) from around 18/1100UTC. Geomagnetic activity initially Active (Kp4) fell to Quiet levels (Kp1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) remained below the S1/Minor Radiation Storm levels on a slow decline, but above normal background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels. The associated 24-hour fluence has remained below the Active threshold. Observed fluence at 19/0000 UTC of 2.91e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Continued Low to Moderate activity is expected with a persistent chance of M-class flares and a slight chance of isolated X-class (High) activity. AR3685 in the southeast is most likely to be the source of significant flare activity.

Solar Wind / Geomagnetic Activity: There is an unlikely, but slight chance of a glancing impact from a CME early day 1 (19 May). A more notable CME arrival may glance the Earth late day 2

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(20 May) or perhaps early day 3 (21 May), resulting from the M7.2 flare of AR3685 that occurred late on 17 May.

In the absence of any CME arrivals solar winds are forecast to remain at generally background speeds, with no significant coronal hole enhancements expected.

Generally Quiet conditions are expected through the early period, but with a very slight chance of Active to G1/Minor Storm conditions on day 1 (19 May) subject to the unlikely potential for a CME arrival. A more significant glancing CME blow is possible late day 2 (20 May) into day 3 (21 May) with a chance of G1-G2/Minor-Moderate (Kp5-6) intervals and a slight chance of G3/Strong (Kp7) intervals should we see a more significant impact. Activity should then subside towards Quiet to Unsettled levels again by the end of day 4 (22 May).

Energetic Particles / Solar Radiation: Proton flux is below the S1/Minor Storm threshold, on a declining trend. There is a persistent slight chance of further enhancements should any large flares occur. High energy electron flux is at background to moderate levels, however there is the potential for electron flux to rise and potentially reach persistently high levels on day 2 and 3 (19 and 20 May). Any rise in electron flux is expected to be curtailed by further CME influence, most likely occurring late day 3 (20 May) or early day 4 (21 May).

The associated 24 hour fluence is expected to continue a rising trend between days 1 and 2 (19 and 20 May) with a chance to reach the Active threshold into days 3 and 4 (21-22 May), though dependent on the extent of any CME enhancement.

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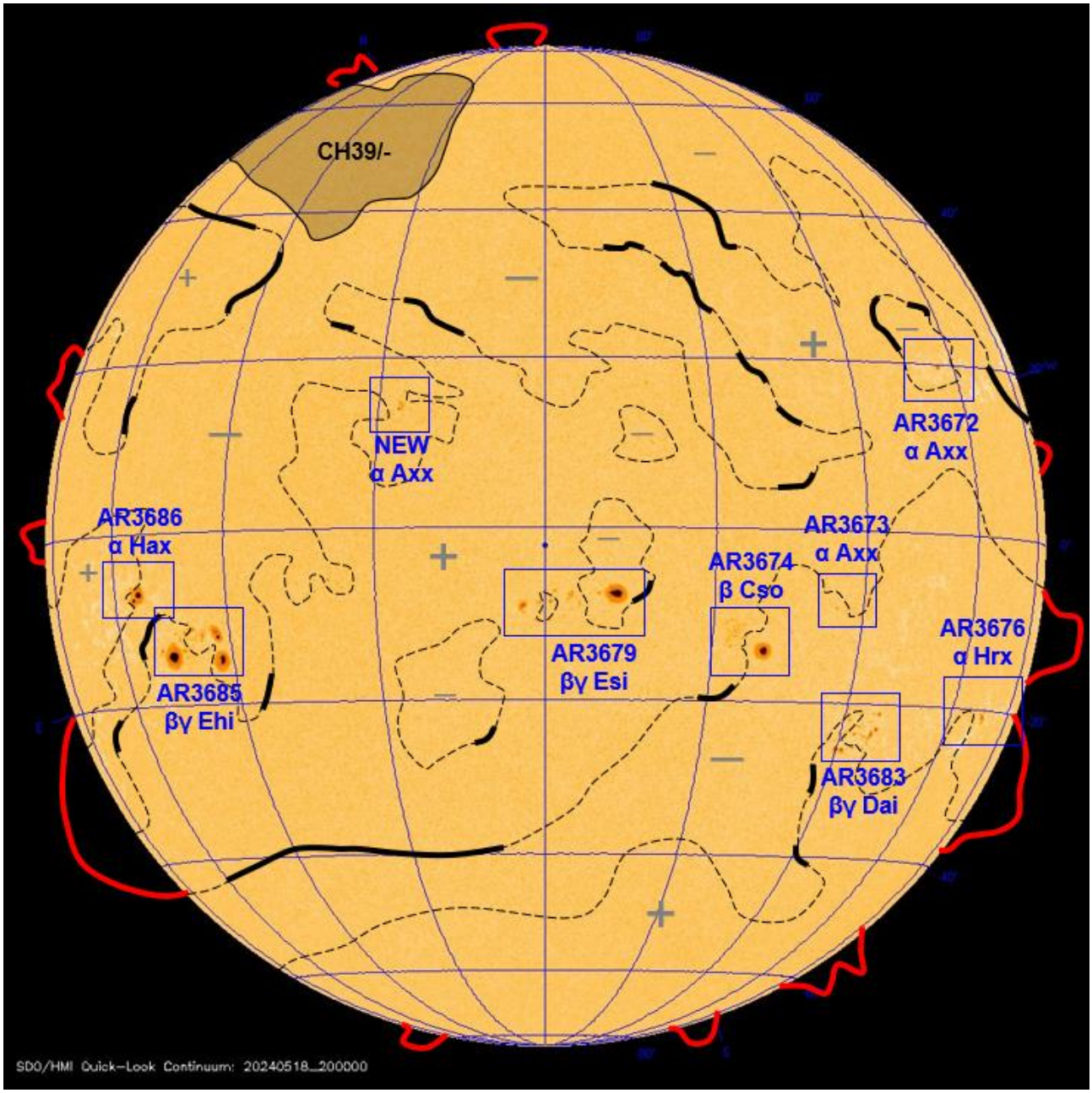
Figure 1. Solar Analysis Valid 18/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Two potentially Earth-directed CMEs currently feature in the forecast period. A filament eruption from the northeast disc around 15/1000 UTC resulted in a CME that has been modelled to pass north of Earth's orbit early day 1 (19 May). Although considered unlikely, there is a slight chance of a glancing impact from this CME. Late on 17 May a complex 'double-structured' moderately-fast CME was seen in coronagraph imagery associated with the M7.2 flare of AR3685 in the southeast disc. Type II and IV Radio Emissions as well as a distinct EUV wave signature were observed. Modelling of this feature suggests the potential for a glancing impact late day 2 (20 May) or perhaps early day 3 (21 May).

In the absence of any CME arrivals solar winds are forecast to remain at generally background speeds, with no significant coronal hole enhancements expected.

Generally Quiet conditions are expected through the early period, but with a very slight chance of Active to G1/Minor Storm conditions on day 1 (19 May) subject to the unlikely potential for a CME arrival. A more significant glancing CME blow is possible late day 2 (20 May) into day 3 (21 May) with a chance of G1-G2/Minor-Moderate (Kp5-6) intervals and a slight chance of G3/Strong (Kp7) intervals should we see a more significant impact. Activity should then subside towards Quiet to Unsettled levels again by the end of day 4 (22 May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	50	50	10
Strong	G3	No	1	10	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/1632	Partial	Filament	NE	630km/s	19/0000 UTC +-7hrs	Slight chance of glancing impacts
18/0039	Partial	AR3685	SE	950 km/s	20/2000 UTC +-10hrs	Chance of glancing impacts

Figure 2: Latest MOSWOC ENLIL output, showing the M7.2 CME passing mostly behind and below Earth orbits but with a chance of lancing interaction

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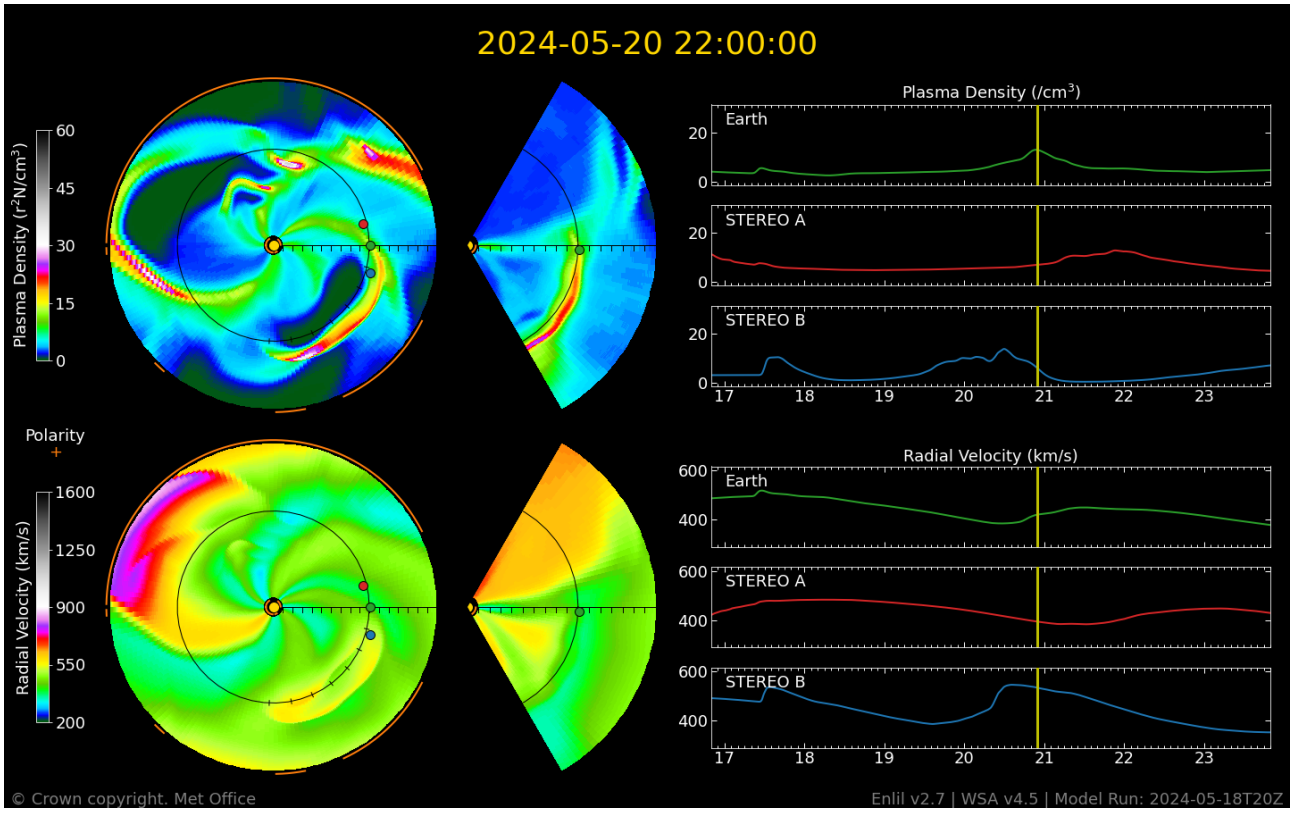

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Radio Blackouts - X-Ray Flares:
There are ten sunspot regions on the visible disc. AR3685 (Ehi-Beta-Gamma) in the southeast is considered to be the most likely source for X-class activity, having produced X2.9 and M7.2 flares on 15 May and 17 May respectively. The region is composed of a number of large, mature spots with several smaller spots of mixed polarity present, though these appear to evolve slowly. AR3679 (Esi/Beta-Gamma) near centre-disc is the next largest region and has been the source of some C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 (Dsi/Beta-Gamma) in the southwest indicates modest magnetic complexity with numerous small spots at this time. The other sunspot regions are generally smaller, simpler and more stable.

No significant returning regions are expected through the period or strongly signaled in far-side sounding data, with all the current notable flare producing regions remaining on the visible disc though the next four days. As such, the current flare risks have been maintained through the period pending further developments.

Continued Low to Moderate activity is expected with a persistent chance of M-class flares and a slight chance of isolated X-class (High) activity, this most likely from AR3685.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

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Solar Radiation Storms - (High Energy Protons):
Proton flux is below the S1/Minor Storm threshold, on a declining trend, but remains just above normal background levels following recent flare activity. There is a persistent slight chance of further enhancements should any large flares occur, especially given the number of sunspot regions on the Earth-facing disc. AR3685, the largest and most actively flaring region on the disc will however remain in a generally unfavorable position (in the eastern hemisphere) for significant proton enhancement throughout.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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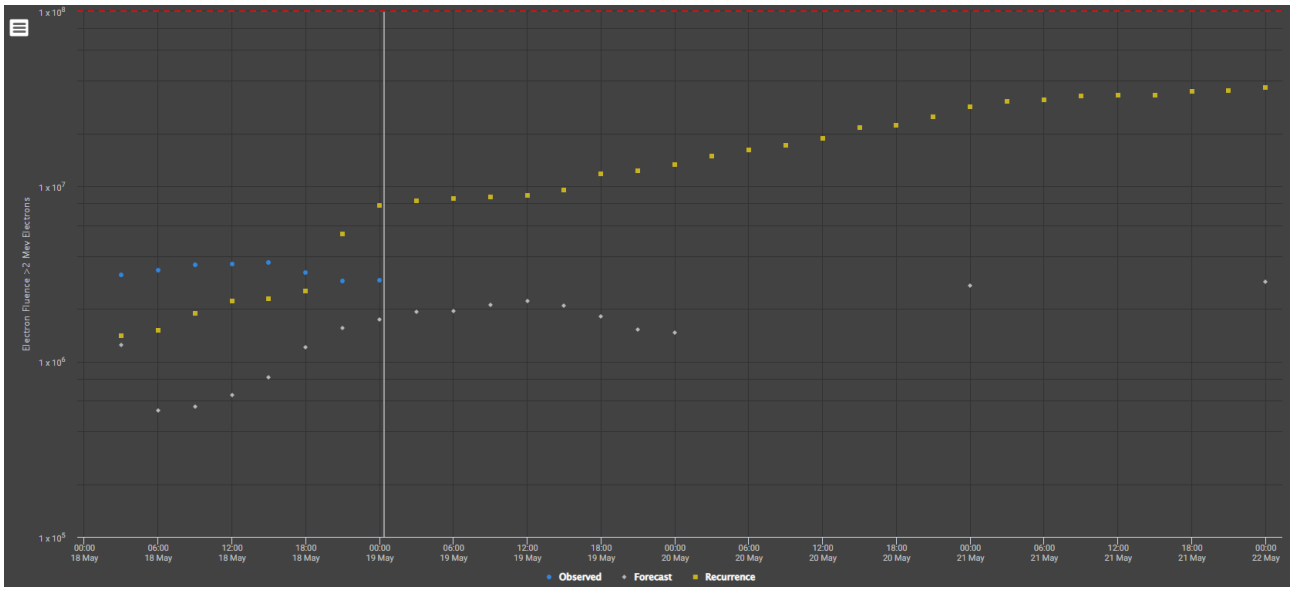
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16 is at background to moderate levels, however there is the potential for electron flux to rise and potentially reach persistently high levels into the period, with lower orbits having been highly charged by numerous strong CME arrivals in the past week or so. Any rise in electron flux may be curtailed by further CME influence however, this most likely late day 2 (20 May) or early day 3 (21 May).

The associated 24 hour fluence is expected to continue a generally rising trend between days 1 and 2 (19 and 20 May) with an increasing chance to reach the Active threshold by days 3 and 4 (21-22 May), though dependent on the extent of any CME enhancement. In the absence of CME enhancement MOSWOC REFM looks to be providing reasonable guidance although perhaps slightly under representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	40	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output.



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